A VALVE ASSEMBLY WITH DAMPER MEANS

This invention relates to a valve assembly and, more especially, this invention relates to a valve assembly with damper means.

Valve assemblies comprising a reed and a port which is opened and closed by the reed are well known. Such valve assemblies are often used in compressors or pumps where the reed acts as an automatic valve for controlling the opening and closing of the port. The compressors may be reciprocating compressors for refrigerant vapour in refrigerant apparatus. Known valve assemblies may be such that the port is in a valve plate at the top of a cylinder containing a reciprocating piston. When pressure in the cylinder drops below suction pressure, there is a delay in the valve opening because of factors such for example as the reed sticking to a valve seat around the port. Delays in the opening of the valve result in a significant pressure drop existing across the reed as the valve assembly opens. The effect of this pressure drop is that the reed initially opens much further than its optimum lift and this introduces unnecessary bending stresses in the reed. Furthermore, after the reed has initially opened, it tends to oscillate to and fro. If this oscillation is too vigorous, then it may delay closing of the reed on the port. Prompt closing is usually required, for example in refrigerant apparatus when a piston in a cylinder is at

bottom dead centre and the prompt closing gives better filling of the cylinder with refrigerant.

It is an aim of the present invention to reduce the above mentioned problems.

Accordingly, in one non-limiting embodiment of the present invention there is provided a valve assembly comprising a reed, a port which is opened and closed by the reed, and damper means for the reed, the damper means comprising a tube which is in communication with the port on a side of the port remote from the reed, and the tube being of such a size that, in use of the valve assembly, the tube contains sufficient fluid to provide substantial damping for the reed.

The use of the damping means for the reed avoids unnecessary lift of the reed as it initially opens from the port. This in turn avoids subjecting the reed to unnecessary bending stresses. The use of the damper means also dampens the subsequent oscillations of the reed after it has initially moved away from the port, and the damping of the oscillations helps to ensure that the reed closes promptly on the port. In cases where the valve assembly is used in piston and cylinder refrigerant apparatus, then the valve is able to close promptly when the piston is at bottom dead centre, thereby resulting in better filling of the cylinder with refrigerant.

Usually, the tube will be such that it extends vertically above the port. If desired, the tube may be

positioned away from the port and appropriately connected to the port.

The valve assembly may be one in which the port is in a valve plate, and in which the length of the tube is greater than the diameter of the port. The length of the tube may be at least twice the diameter of the port. Generally, the tube will provide more damping as its length increases. The length of the tube may vary depending upon where the valve assembly is used.

The present invention also provides a compressor or a pump when including the valve assembly of the invention.

An embodiment of the invention will now be described solely by way of example and with reference to the accompanying drawing which is a simplified cross sectional view of a compressor cylinder provided with a valve assembly.

Referring to the drawing, there is shown part of a compressor 1 comprising a piston 3 which reciprocates in a cylinder 4 formed from a cylinder block 5 and a cylinder head comprising a valve plate 7. The valve plate 7 is attached to the cylinder block 5 by means of mounting bolts (not shown) through a gasket 9. The valve plate 7 may be divided by a baffle (not shown) into an inlet side and a discharge side. For simplicity of illustration, the discharge side has not been shown in the drawing.

The inlet side is provided with a valve assembly 9. The valve assembly 9 comprises a reed 11 and a port 13

which is provided in the valve plate 7 and which is opened and closed by the reed 11. The valve assembly 9 also comprises damper means 15 for the reed 11.

The damper means 15 comprises a tube 17 which is in communication with the port 13 on a side 19 of the port 13 remote from the reed 11. The tube 17 is of such a size that, in use of the valve assembly 9, the tube 17 contains sufficient fluid to provide substantial damping for the reed 11.

As can be seen from the drawing, the tube 17 is such that it extends vertically above the port 13. The port 13 is in the valve plate 7 and the tube 17 is of a length which is several times greater than the diameter of the port 13.

When the piston 3 moves downwardly in the cylinder 4 towards its bottom dead centre position, it causes the reed 11 to move away from the port 13 as indicated by the position of the reed 11 shown in broken lines in the drawing. Without the damping means 15, the reed 11 could initially bend too far and thereby become subject to unnecessary bending stresses. After the reed 11 has initially moved away from the port 13, it tends to oscillate backwards and forwards over an area. If the oscillations are excessive, they tend to delay the prompt closing of the valve 11 about the port 13 when the piston 3 reaches bottom dead centre. The damper means 15 is also effective to ensure that the oscillations of the reed 11

are reduced so that the reed 11 is able to close the suction port 13 faster than it would normally do. The dampening of the reed 11 by the damper means 15 ensures that refrigerant is able to flow into the suction side of the valve plate 7 with a much smoother flow than would be the case if the damper means 15 were not employed. The smoother flow is advantageous in that it results in the production of less noise. It is always desirable to reduce on the noise output from compressors used in refrigerant apparatus.

The damper means 15 operates by effectively providing a plug of fluid in the tube 17. For simplicity of explanation, the fluid being pumped by the compressor 1 is considered to be incompressible. At the instant the reed 11 starts to open, there is a significant pressure drop across the reed 11. If the pressure drop were to be maintained while the valve assembly 9 opened, the force on the reed 11 would deflect it well past its equilibrium position as indicated above. The geometry of the valve assembly 9 may act to modify the force acting on the reed 11, but the reed 11 will still overshoot, and then it will cycle about an equilibrium position as mentioned above.

For the force on the reed 11 to be maintained, as the reed 11 opens, the fluid above the reed 11 must move with the reed. In order for the fluid to move with the reed 11, the fluid must accelerate and it will absorb energy. The energy absorbed by the fluid is a function of the velocity

squared and its mass. The more energy that is absorbed by the fluid, the less energy there is for transferral to the reed 11, and thus the maximum deflection of the reed 11 is able to be reduced. The required velocity of the fluid in the tube 17 is a function of the velocity of the reed 11. The tube 17 provides a mass of fluid which moves at the same velocity as the reed 11, and which results in less energy being transferred to the reed 11.

When the reed 11 tries to close, the opposite effect occurs. The reed 11 now has to stop the plug of fluid in the tube 17 which is flowing towards it, thus damping the closing of the reed 11.

By definition, the compressor 1 does not pump incompressible fluids and therefore the detail of the damping as described above is modified but, nevertheless, the damping principle as described above still applies.

By using the damper means 15, the volumetric efficiency of the compressor 1 is able to be improved. The noise generated by the compressor 1 and its associated equipment is able to be reduced. Unwanted failures of the reed 11 are also able to be reduced.

It is to be appreciated that the embodiment of the invention described above with reference to the accompanying drawing has been given by way of example only and that modifications may be effected. Thus, the drawing shows the tube 17 as a simple tube which is of the same diameter as the port 13. If desired, the tube 17 may be of

a different diameter to the port 13. The tube 17 may also be positioned remote from the port 13 and connected directly to the port 13. The tube 17 could be formed as a passage in a cylinder head or in some other means. The reed 11 may be a reed which has a projection which engages with a stop member in the cylinder wall, the stop member limiting movement of the reed to a small degree. Such a reed is disclosed in UK Patent No. 2105821A. The reed may also be an elongate resilient reed of the type disclosed in UK Patent No. 2161583. The reed may still further be a reed with a straight end as disclosed in UK Patent Application No. 9825550.8.